



**U.S. Department of Energy
Energy Efficiency and
Renewable Energy**

Bringing you a prosperous future where energy
is clean, abundant, reliable, and affordable

INDUSTRIAL TECHNOLOGIES PROGRAM

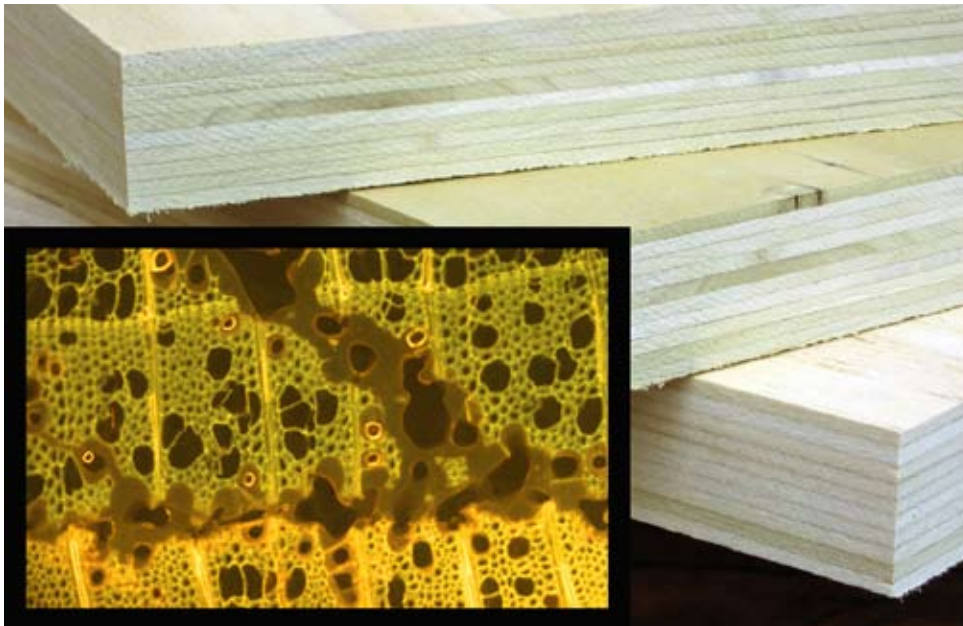
Novel Isocyanate-Reactive Adhesives for Structural Wood-Based Composites

New Cold-Setting Processes Will Reduce Energy Use and Improve Environmental Performance

Laminated veneer lumber (LVL) is a wood-based composite material that is produced for either structural or nonstructural applications. LVL is produced by bonding thin wood veneers (thin sheets of wood) together so that the grain of all the veneers is parallel to the long direction of the lumber product. Structural LVL is used for support beams, headers, rafters, and I-beams; nonstructural LVL is remanufactured into parts for furniture, window, door frames, and cabinets. LVL production is an energy intensive process using adhesives that require extensive wood drying and high temperature hot-pressing.

North American LVL production is based upon thermosetting resol phenol-formaldehyde (PF).

This adhesive technology requires substantial veneer drying (moisture contents of 6-8%) and high temperature hot-pressing (around 200°C). An alternative isocyanate-reactive adhesive which cures at room temperature (cold-setting) and is optimized for higher veneer moisture contents promises significant energy savings. Cold-setting adhesive technology will eliminate hot-pressing and reduce veneer drying. This new technology will not only save energy but will also sharply reduce emissions of volatile organic compounds (VOCs) associated with veneer drying. Furthermore, reduced veneer drying could improve the durability of LVL bond lines (excessive drying can harm the veneer surface energy).



Pilot-scale poplar LVL. The inset fluorescent micrograph shows the adhesive bondline of an LVL sample.



Benefits for Our Industry and Our Nation

The development of a cold-setting adhesive promises to provide energy savings up to 53 trillion Btu (British thermal units) per year and will also reduce nitrogen oxide emissions by almost 13 million pounds per year. The use of higher moisture content veneer will also reduce the tendency for veneer drying, and the related energy use. Bond line durability could also be improved.

Applications in Our Nation's Industry

Cold-setting adhesives could replace the hot-press adhesives currently used by the U.S. LVL manufacturing industry. These new adhesives could also produce colorless bond lines that would enable the American LVL manufacturers to compete in European and Asian appearance-grade LVL markets.

Project Partners

Virginia Polytechnic Institute & State University
Blacksburg, VA

Trus Joist—A Weyerhaeuser Business
Boise, ID

National Starch and Chemical
Berkeley, CA

Project Description

The goal of this project is to develop a novel cold-setting adhesive that will pass the ASTM delamination test for the manufacture of laminated veneer lumber (LVL). The project will focus on southern pine and yellow-poplar veneer, and will develop two parallel adhesive technologies. One adhesive system will be a completely organic (100 percent solids), isocyanate-reactive polyurethane. The second system will be a two-part reactive latex crosslinked by polyisocyanates. The primary objective is to develop a cold-setting adhesive that will pass the delamination test (ASTM D2559-03), a wood adhesive specification that must be met before any adhesive can be used for LVL manufacture in North America. The experimental adhesives will also be tested by standard mechanical test evaluations of structural composite lumber.

Pathways

The objectives of this project will be achieved through (1) establishing delamination test protocol as per ASTM D2559-03; (2) preparing and developing the anticipated adhesive technology based on two strategies: (a) 100 percent organic, isocyanate-reactive polyurethanes and (b) reactive latex crosslinked with polyisocyanates; (3) conducting adhesive analyses to guide adhesive development; and (4) manufacturing and mechanical testing of LVL samples produced with new adhesives.

Barriers

- Early formulations of isocyanate-reactive polyurethanes were unable to pass the delamination test. This will be a major hurdle before the project can move forward.

Milestones

- Pass delamination testing with acceptable small-scale LVL test results
- Pass delamination testing with acceptable large-scale LVL test results
- Perform mill trial feasibility study
- Conduct mill trial

Commercialization

Trus Joist (a Weyerhaeuser Company) is the largest LVL producer in North America with an interest in commercializing the technology. National Starch and Chemical Company is a world-wide innovator and supplier in the adhesives industry. National Starch will develop and supply the adhesive to Virginia Tech. Virginia Tech will manufacture a pilot-scale LVL which will be tested by Trus Joist. Trus Joist will be developing the adhesive technology, conducting mechanical testing of small-scale LVL samples (prepared by Virginia Tech), and manufacturing large-scale LVL samples as more promising adhesives are developed.

For additional information, please contact:

Drew Ronneberg, Ph.D.
Industrial Technologies Program (ITP)
Phone: (202) 586-0205
Fax: (202) 586-9234
E-mail: Drew.Ronneberg@ee.doe.gov

Charles Frazier, Ph.D.
Virginia Polytechnic Institute & State University
Blacksburg, VA
Phone: (540) 231-8853
Fax: (540) 231-8176
E-mail: cfrazier@vt.edu

A Strong Energy Portfolio for a Strong America

Energy efficiency and clean, renewable energy will mean a stronger economy, a cleaner environment, and greater energy independence for America. Working with a wide array of state, community, industry, and university partners, the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy invests in a diverse portfolio of energy technologies.

For more information contact:
EERE Information Center
1-877-EERE-INF (1-877-337-3463)
www.eere.energy.gov



U.S. Department of Energy
Energy Efficiency
and Renewable Energy
Bringing you a prosperous future where energy
is clean, abundant, reliable, and affordable